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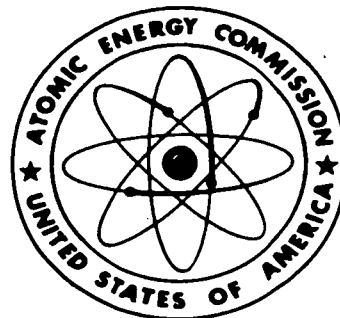
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(FINAL)

EFFECTS EVALUATION

FOR

PROJECT RULISON



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JUNE 1969

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EFFECTS EVALUATION - PROJECT RULISON

June 1969

EFFECTS EVALUATION - PROJECT RULISON

TABLE OF CONTENTS

	<u>Page No.</u>
1.0 Introduction	1
2.0 Current Technical Event Data	3
3.0 Effects Predictions and Evaluations	3
✓ 3.1 Ground Motion	3
✓ 3.2 Structural Response	4
✓ 3.3 Ground Water Contamination	7
✓ 3.4 Containment	12
✓ 3.5 Meteorology and Fallout	12
✓ 3.6 Bioenvironmental	15
✓ 3.7 Snow Slides	20
✓ 3.8 Close-In Effects	20
✓ 3.9 Aftershocks	20
✓ 3.10 Reservoir Structures	21
✓ 3.11 Mines and Gas Wells	22
4.0 Effects Programs	25
4.1 Seismic Instrumentation Program	25
4.2 Structural Response Program	27
4.3 Hydrologic Safety Program	28
4.4 Mines and Gas Wells	28
5.0 Effects Prediction Summary	28

Table of Contents (cont'd)

	<u>Page No.</u>
Figure 1 - Index Map of Project Rulison Site	2
Figure 2 - Predicted Peak Horizontal Acceleration Versus Distance, Rulison Event, 40kt and 60kt Yields, Hard Rock Stations	6
Figure 3 - Rulison Structure Summary	9
Figure 4 - Water Wells and Springs in the Vicinity of the Rulison Project, USGS Inventory	11
Figure 5 - Project Rulison, Generalized Geologic Cross Section	13
Figure 6 - Rulison Population Summary	17
Figure 7 - Rulison Population Summary	19
Figure 8 - Dams in the Vicinity of Project Rulison	23
Figure 9 - Mineral Industry Development in Vicinity of Project Rulison	24
Figure 10 - Possible Rockfall and Slide Hazard Areas Near Project Rulison	31
Table I - Summary of Phenomenology and Containment Predictions	14
Table II - ESSA/C&GS Seismic Instrumentation Plan	26
Appendix A - Safety Panel of Consultants Statement, April 11, 1969	
Appendix B - Safety Panel of Consultants Statement, May 1, 1969	

EFFECTS EVALUATION - PROJECT RULISON

FOREWORD

The Effects Evaluation report reflects the culmination of efforts the Nevada Operations Office (NVOO) of the Atomic Energy Commission undertakes to evaluate all hazards that may be associated with a nuclear detonation. The philosophy of NVOO with regard to these hazards has been defined in the following manner:

"A nuclear device can be detonated safely when it is ascertained that the detonation can be accomplished without injury to people, either directly or indirectly, and without unacceptable damage to the ecological system and natural and man-made structures."

The evaluation of the hazards associated with the Rulison Event, as summarized in this report, is utilized in the development of procedures to assure that the detonation can be conducted safely. These procedures are reflected in the Project Rulison Safety Plan.

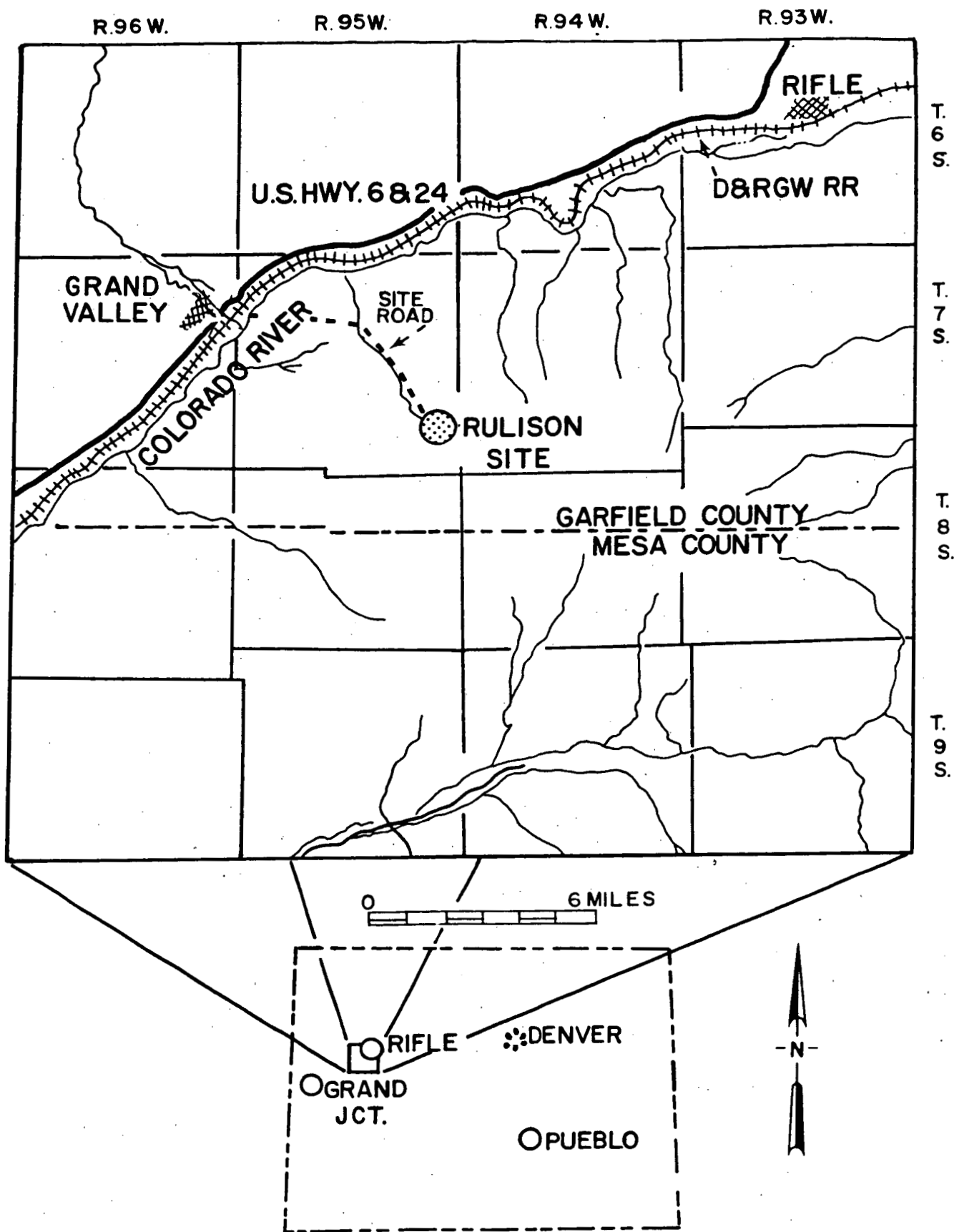
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EFFECTS EVALUATION - PROJECT RULISON

1.0 INTRODUCTION

Project Rulison, located in Garfield County, Colorado, (Figure 1), is a joint Industry-Government nuclear explosive gas stimulation experiment in the Atomic Energy Commission (AEC) Plowshare Program. This is the third Plowshare and eighth underground nuclear detonation conducted by the AEC at locations other than the Nevada Test Site (NTS). The project, sponsored by Austral Oil Company, Inc. of Houston, Texas with CER Geonuclear Corporation of Las Vegas, Nevada as Program Manager, is defined in the Project Rulison Definition Plan prepared by CER Geonuclear Corporation. The Effects Evaluation was prepared by Dr. R. Lee Aamodt of Los Alamos Scientific Laboratory and Mr. Richard A. Johnson of the Effects Evaluation Division, Nevada Operations Office, with predictions, evaluations and program descriptions contributed by the Environmental Research Corporation, John A. Blume & Associates Research Division, U. S. Geological Survey, U. S. Bureau of Mines, Battelle Memorial Institute, Environmental Science Services Administration/ U. S. Coast and Geodetic Survey, Environmental Science Services Administration/Air Resources Laboratory, U. S. Public Health Service Southwestern Radiological Health Laboratory and Isotopes, A Teledyne Company.

The Rulison Project is reviewed formally by three Nevada Operations Office (NVOO) groups. The Test Evaluation Panel (TEP) reviews the



INDEX MAP OF PROJECT RULISON SITE

1.0 INTRODUCTION (CONT'D)

containment aspects (possibility of release of radioactivity to the atmosphere) of the project and the Safety Panel of Consultants reviews the predicted ground motion, structural response, slope stability, hydrology and ground water contamination effects. The TEP evaluation is cited in Paragraph 3.4. The Safety Panel of Consultants reviews are included as Appendixes A and B. The Nuclear Safety Study Group (NSSG) performs a review of the assembly, transportation, emplacement and firing phases of the nuclear operation in order to provide assurance that no accidental detonation will occur. Nuclear safety procedures for the assembly and transportation of the Rulison explosive to the emplacement site and for emplacing and firing have been reviewed and approved.

2.0 CURRENT TECHNICAL EVENT DATA

Yield:	Design	40 Kiloton (kt)
	Maximum Credible	60 Kiloton (kt)
Depth of Burial:*		8442.5 feet
Geologic Environment:		Mesaverde Shale/Sandstone

3.0 EFFECTS PREDICTIONS AND EVALUATIONS

3.1 Ground Motion

Ground motion predictions have been developed by the Environmental Research Corporation (ERC) for the Rulison design and maximum

*NTS criteria for containment of a 60kt device requires a depth of burial of 1380 feet. Rulison has a safety factor 6 times this value.

3.1 Ground Motion (cont'd)

credible yield. The predictions are based on the assumption that ground motions produced by the Rulison detonation (Piceance Creek Basin) will be similar to those from the Gasbuggy detonation (San Juan Basin). The bases for this assumption are: (1) the similarity of the geologic environments in which each explosive is emplaced, (2) the over buried nature of the explosive at both sites which cause higher frequency motions to be generated, and (3) the generally similar nature of the amplification of the near surface materials which favors high frequencies at both sites.

Data from the Gasbuggy stations located on hard rock and alluvium were grouped together for use as a Rulison "Hard Rock" data base for sites within the Piceance Creek Basin as little or no amplification of motion was observed at the Gasbuggy alluvium stations. Predictions of peak particle acceleration, velocity and displacement for locations of interest on alluvium outside the Piceance Creek Basin were made using a hard rock-alluvium amplification ratio developed on the basis of NTS experience. Predictions of peak horizontal particle accelerations at "Hard Rock" locations of interest are shown on Figure 2.

3.2 Structural Response

Based on the predictions of ground motions described in Paragraph 3.1, John A. Blume & Associates Research Division (JAB) has pre-

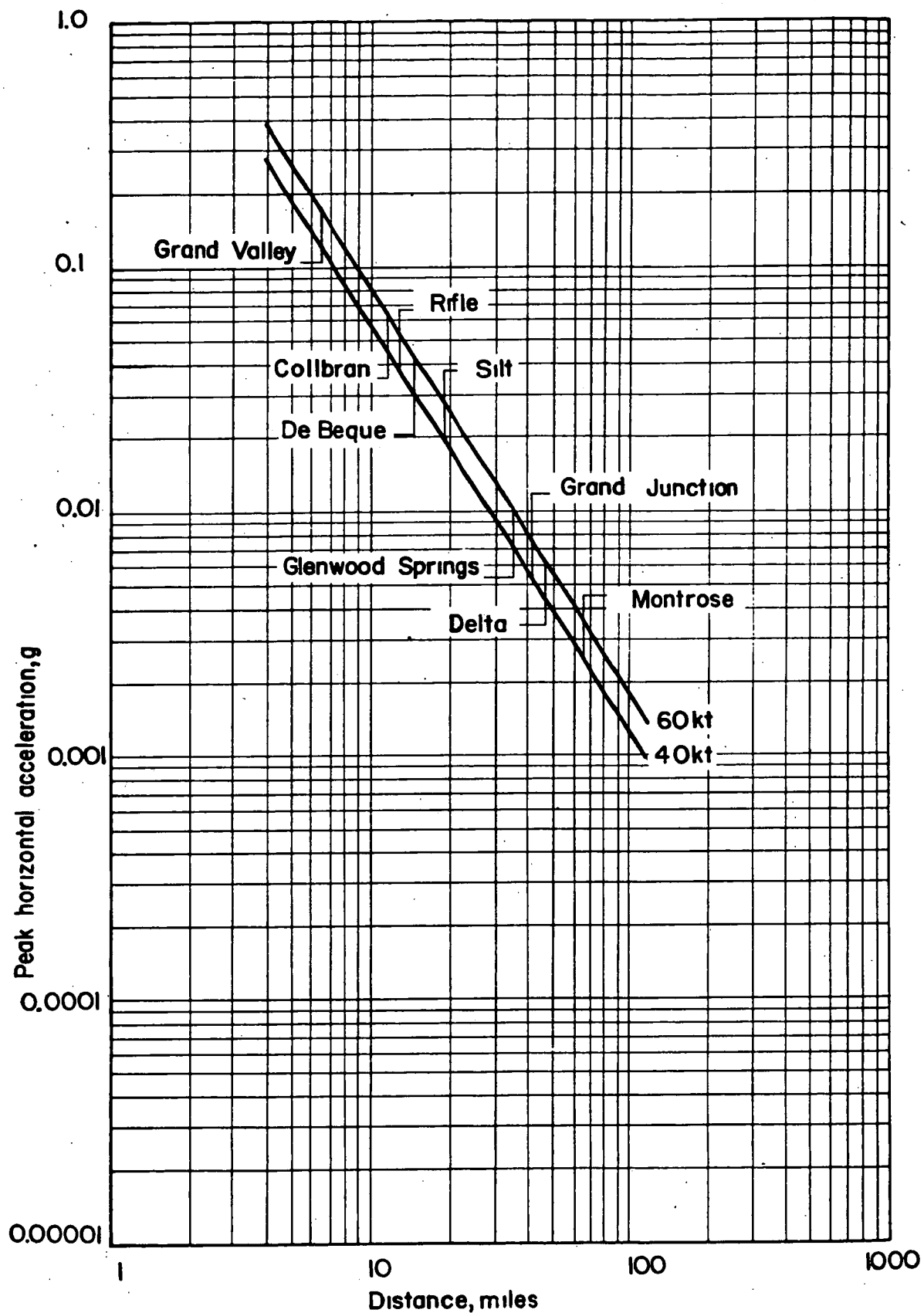
FIGURE NO. 2

PREDICTED PEAK HORIZONTAL ACCELERATION
VERSUS DISTANCE, RULISON EVENT
40KT AND 60KT YIELDS

Note:

Figure 2 indicates peak particle acceleration (in units of gravity 32.2 feet per second per second) which various locations are predicted to receive. The curves are predictions for the nominal 40kt yield (the equivalent explosive force of 40,000 tons of TNT) and the maximum credible yield of 60kt. For Glenwood Springs, the peak particle acceleration prediction for a 40kt yield is 0.007g, and for a maximum credible yield of 60kt is 0.01g.

(Figure 2 - Page 6)



Predicted Peak Horizontal Component of Acceleration versus Distance, Rulison Event, 40kt and 60kt Yields, Hard Rock Stations.

3.2 Structural Response (cont'd)

pared an inventory of structures within a radial distance of 15.0 miles from the detonation point (Figure 3) and have generally surveyed the number and types of structures out to distances of about 60 miles. Canyon and valley sections with slope areas or cliffs which may not be stable under the dynamic action of the ground motion have been identified (Section 5.0). The response of irrigation facilities, dams and reservoirs to the resulting ground motion has also been evaluated (Paragraph 3.11). The Blume organization will complete a detailed condition survey (for documentation purposes) of many typical structures in the vicinity of the shot prior to the detonation, selecting the greater number near the detonation site and reducing the number to be examined as predicted ground motion from the detonation becomes less. About 35 structures will be surveyed in this manner. Slopes, cliffs and dams will be monitored to evaluate their response to the detonation ground motion.

3.3 Ground Water Contamination

To define the hydrologic regime for the detonation, the U. S. Geological Survey (USGS) participated in the hydrologic testing of the exploratory hole. After installation of the casing, hydrologic tests were performed by perforating the casing at

FIGURE 3

RULISON STRUCTURE SUMMARY

Note:

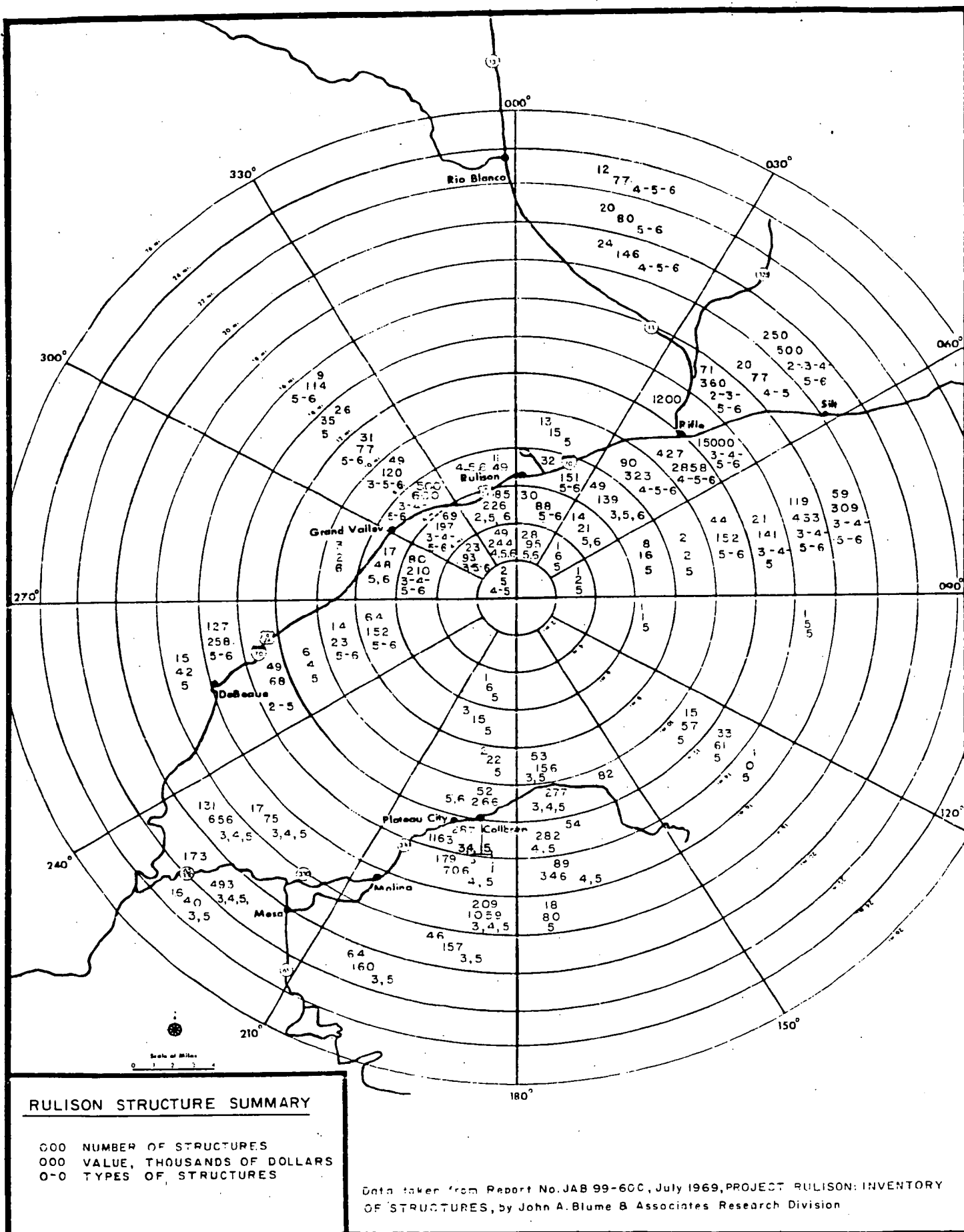
The inventory indicated in Figure 3 includes all sectors within 15 miles of project Rulison ground zero. In addition, major population centers including the towns of Mesa, Molina, and Silt have been inventoried for general structural population. Figure 3 indicates (1) the number of structures, (2) the value of the structures in thousands of dollars, and (3) the types of structures in various sectors.

For example, the sector containing the town of Rulison has 32 structures included in this inventory. Total engineering estimate of the value of structures in this area is \$151,000. Structures of classes 5 and 6 are included.

Explanation of Structure Classes

<u>Class No.</u>	<u>Type</u>	<u>Vibration Period, sec.</u>
1	Adobe	0.05 - 0.15
2	Adobe	0.15 - 0.20
3	Brick and Stone	0.05 - 0.15
4	Brick and Stone	0.15 - 0.20
5	Wood Frame	0.05 - 0.15
6	Wood Frame	0.15 - 0.20

(Figure 3 - Page 9)

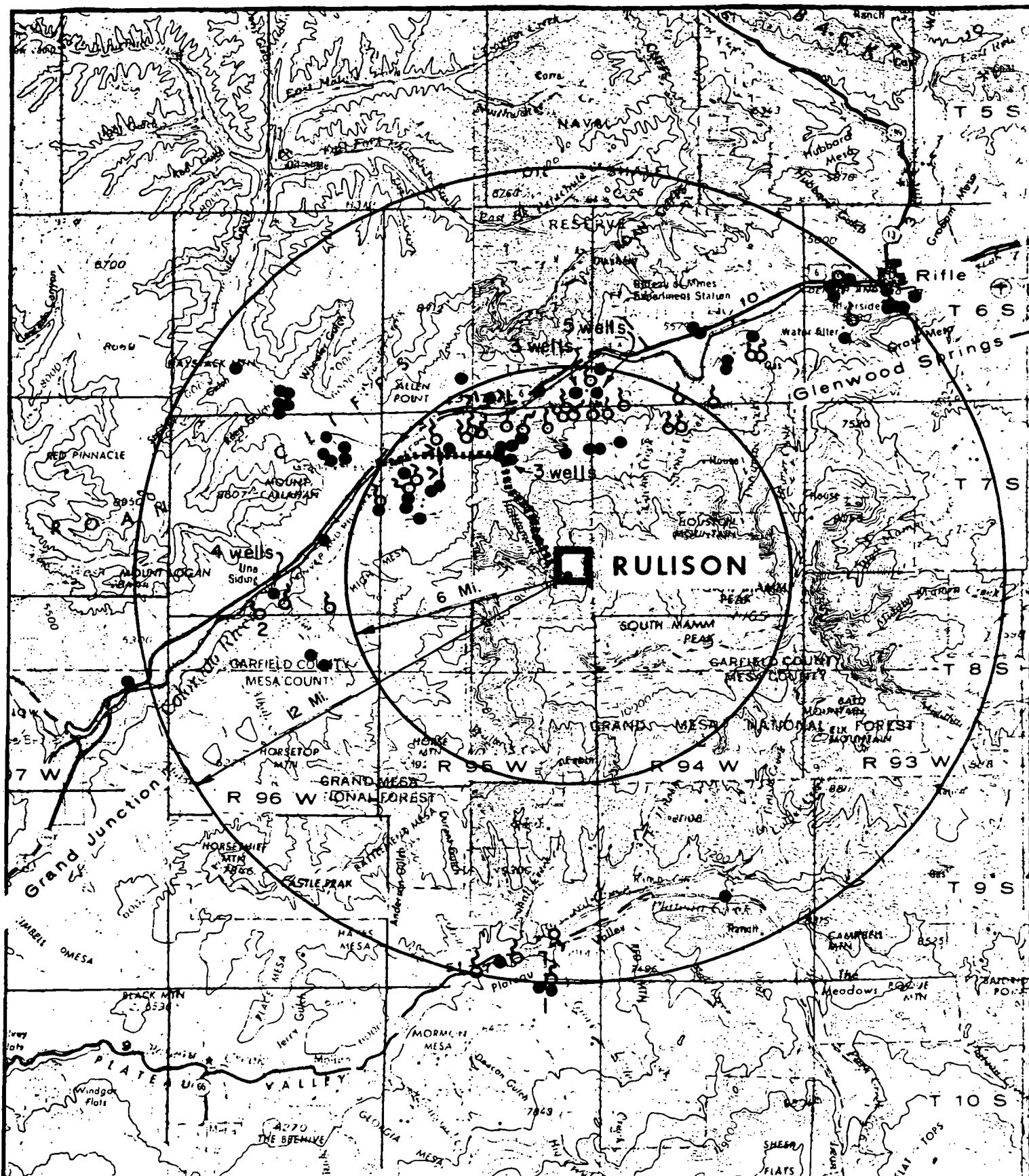


3.3 Ground Water Contamination (cont'd)

depths below 6,000 feet from the surface. All zones that produced any water during drilling or in which geophysical logs suggested the possibility of water were evaluated. The small amounts of liquid that were recovered were analyzed by the USGS and determined to arise mostly from the initial drilling and cementing operations. The USGS conclusion was that little or no mobile water occurs in the Ohio Creek Conglomerate and Mesaverde Group, which are the stratigraphic units most likely to yield water to the hole.

Isotopes, A Teledyne Company (Isotopes) made ground water contamination predictions based on reasonable but conservative assumptions. Isotopes concluded that the probability of transmission of greater than MPC levels of radioactivity in the underground water to any known use point is extremely remote.

In the unlikely event of venting of gaseous debris, small quantities of radionuclides could be introduced into the surface water. Therefore, springs and wells in the vicinity of the Rulison site have been sampled by the USGS. (Figure 4 depicts all wells and significant springs located within 6 miles. In addition, major wells and springs to about 12 miles have been located.) Corresponding samples will be taken after the event.



WATER WELLS AND SPRINGS IN THE VICINITY OF THE RULISON PROJECT
U. S. GEOLOGICAL SURVEY INVENTORY

SCALE 1:250,000

- Well
- Spring
- > Indicates more than one spring at location

3.3 Ground Water Contamination (cont'd)

Near surface water will be monitored as required after the event in a well drilled down hydraulic gradient from surface ground zero.

3.4 Containment

A geologic cross section of the emplacement hole is shown in Figure 5. Predictions of close-in physical effects of the detonation are tabulated in Table I.

The depth of burial for this device is sixtimes that which has been utilized successfully at the NTS to contain underground nuclear detonations. The geologic structure in the vicinity of the detonation has been studied and no major displacements or traces of surface faulting were found. Therefore, the probability of release of radioactivity to the atmosphere by fissures is small. The TEP has reviewed the casing and cementing plan as well as the stemming concept. On the basis of extensive NTS experience the TEP concluded that radioactivity should be contained.

3.5 Meteorology and Fallout

The fallout and climatological predictions show that various combinations of shot time meteorological conditions and firing sectors can be selected such that, should an unexpected radioactive effluent release occur, radiation exposures to off-site populations can be held below the safety criteria established by

PROJECT RULISON

GENERALIZED GEOLOGIC CROSS SECTION

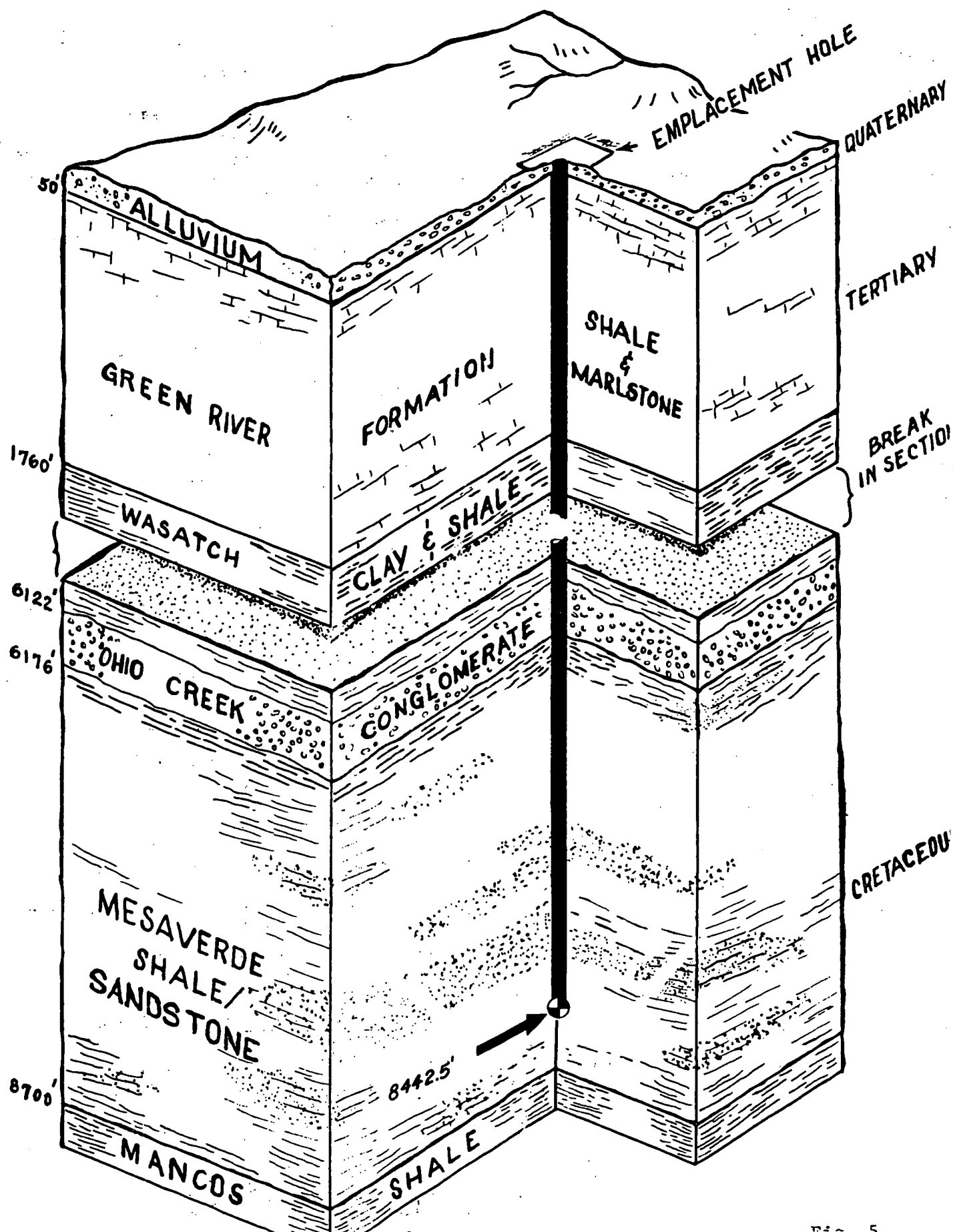


TABLE I
SUMMARY OF PHENOMENOLOGY AND
CONTAINMENT PREDICTIONS

<u>Prediction</u>	<u>Maximum Yield</u>	<u>Design Yield</u>
Cavity Radius	82-122 feet	72-108 feet
Cracking Radius	440-660 feet	390-580 feet
Maximum Radius of Gamma Radioactivity		
Above W.P.	160-280 feet	145-254 feet
Below W.P.	110-178 feet	100-161 feet
Chimney Height	340-510 feet	301-451 feet

DEFINITIONS:

- Cavity Radius - The radius of the void (assumed spherical in most cases) formed in the geologic media by vaporization and compression as a result of the detonation.
- Cracking Radius - The radius to which stress from the detonation exceeds strength of surrounding rock, resulting in the formation of cracks.
- Maximum Radius of Gamma Radioactivity - The radius to which gamma-emitting radionuclides are injected into the cracks formed in the surrounding rock by the detonation.
- W.P. (Working Point) - The point at which the device is to be detonated.
- Chimney Height - The height above the working point from which cracked rock falls to fill the cavity. This occurs when, as a result of both a decrease of pressure in the cavity and cracking in the cavity wall, the cavity can no longer support itself and collapses. The chimney is assumed to be cylindrical in shape.

3.5 Meteorology and Fallout (cont'd)

AEC Headquarters. The AEC Director of Nuclear Operations (DONO) will be prepared to evacuate people prior to the detonation or control people following the detonation such that radiation exposure resulting from an unexpected radioactive effluent release will be maintained within the above criteria.

3.6 Bioenvironmental

The U. S. Public Health Service Southwestern Radiological Health Laboratory is responsible for maintaining a current census of human population and dairy cows and their distribution within a 25-mile radius of the detonation and to 150 miles in the prevailing down-wind semicircle (0° to 180° azimuth). Summaries of this census are depicted in Figures 6 and 7.

An ecological survey of the area around the project site has been made by the Battelle Memorial Institute to evaluate the seasonal wild game and range livestock populations and to identify any significant ecological consequences that might ensue from carrying out the project.

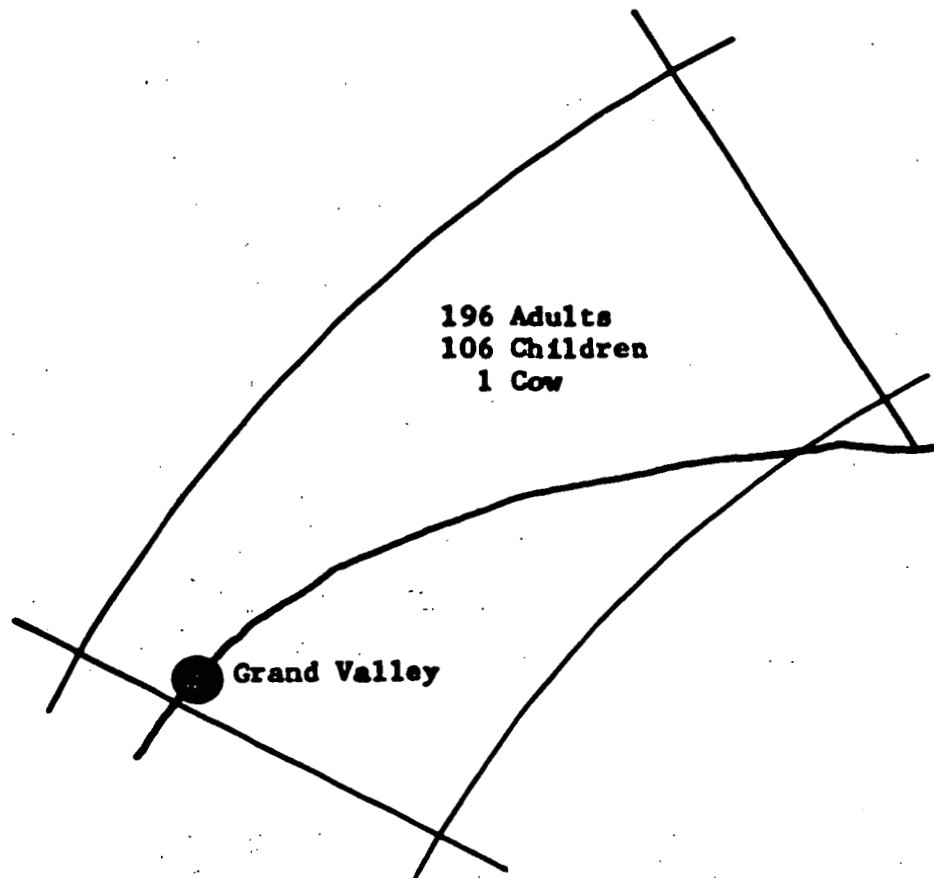
To preclude any possibility of pollution of Battlement Creek as a result of the rupture or instability of the exploratory and emplacement hole mud pit dikes or splashing out as a result of ground motion, Austral Oil will clean the pits and adjacent slopes prior to the detonation. The effectiveness of this

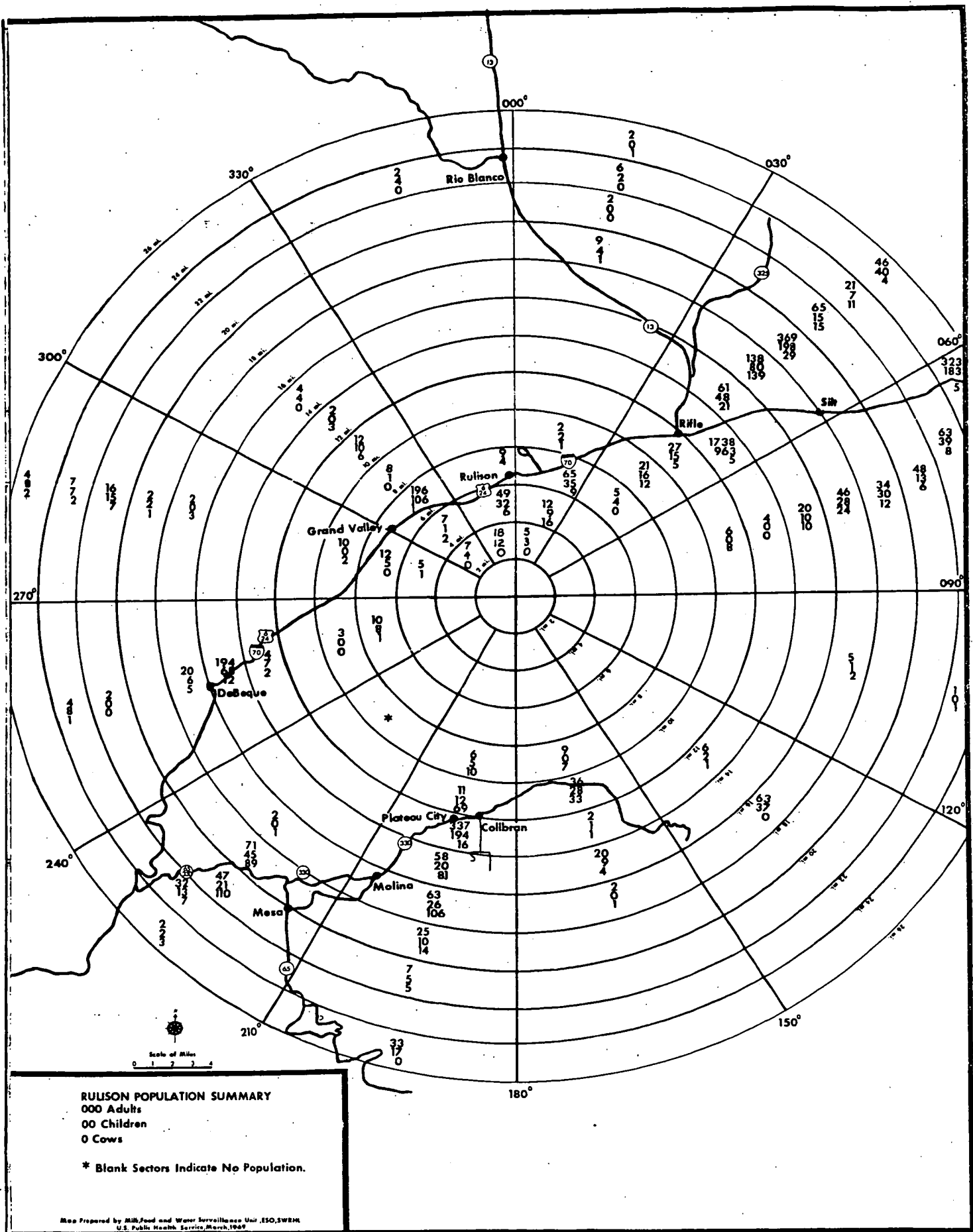
RULISON POPULATION SUMMARY

(Figure 6 - Page 17)

Within a given sector, the top number indicates the number of adults; the middle number indicates the number of children, and the bottom number indicates the number of milk cows in the sector.

For example, the sector containing the town of Grand Valley contains 196 adults, 106 children, and 1 milk cow.



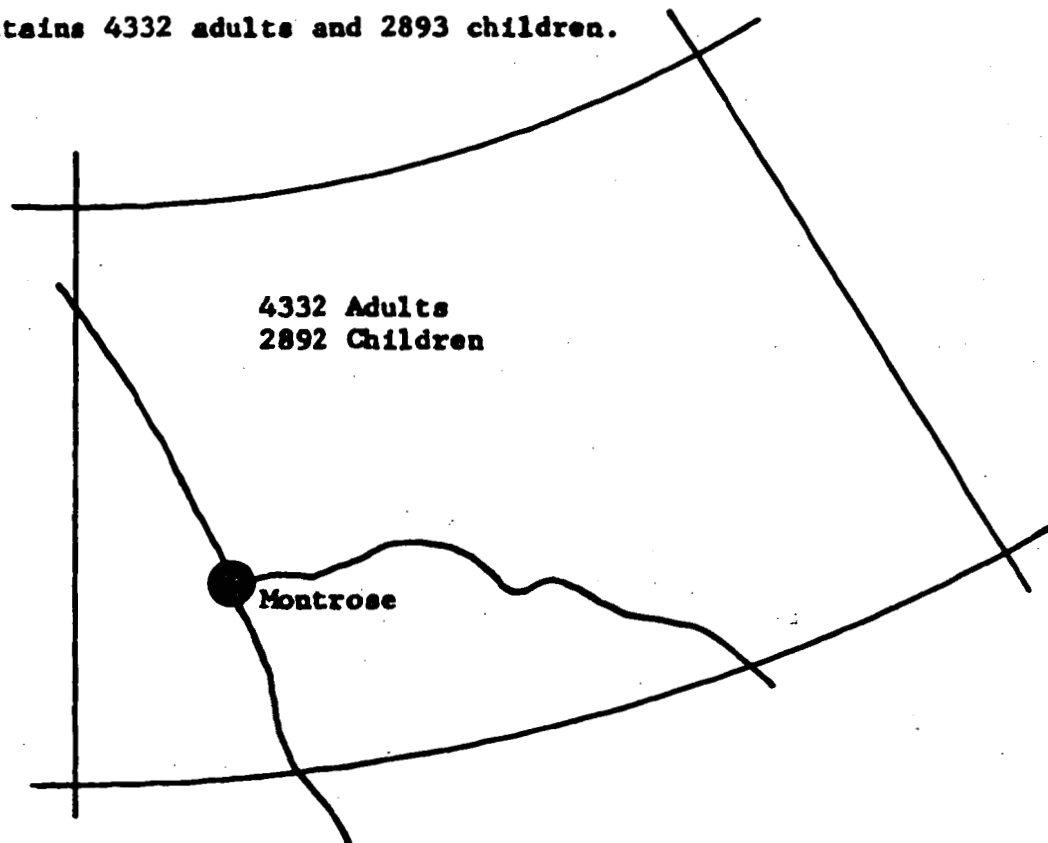


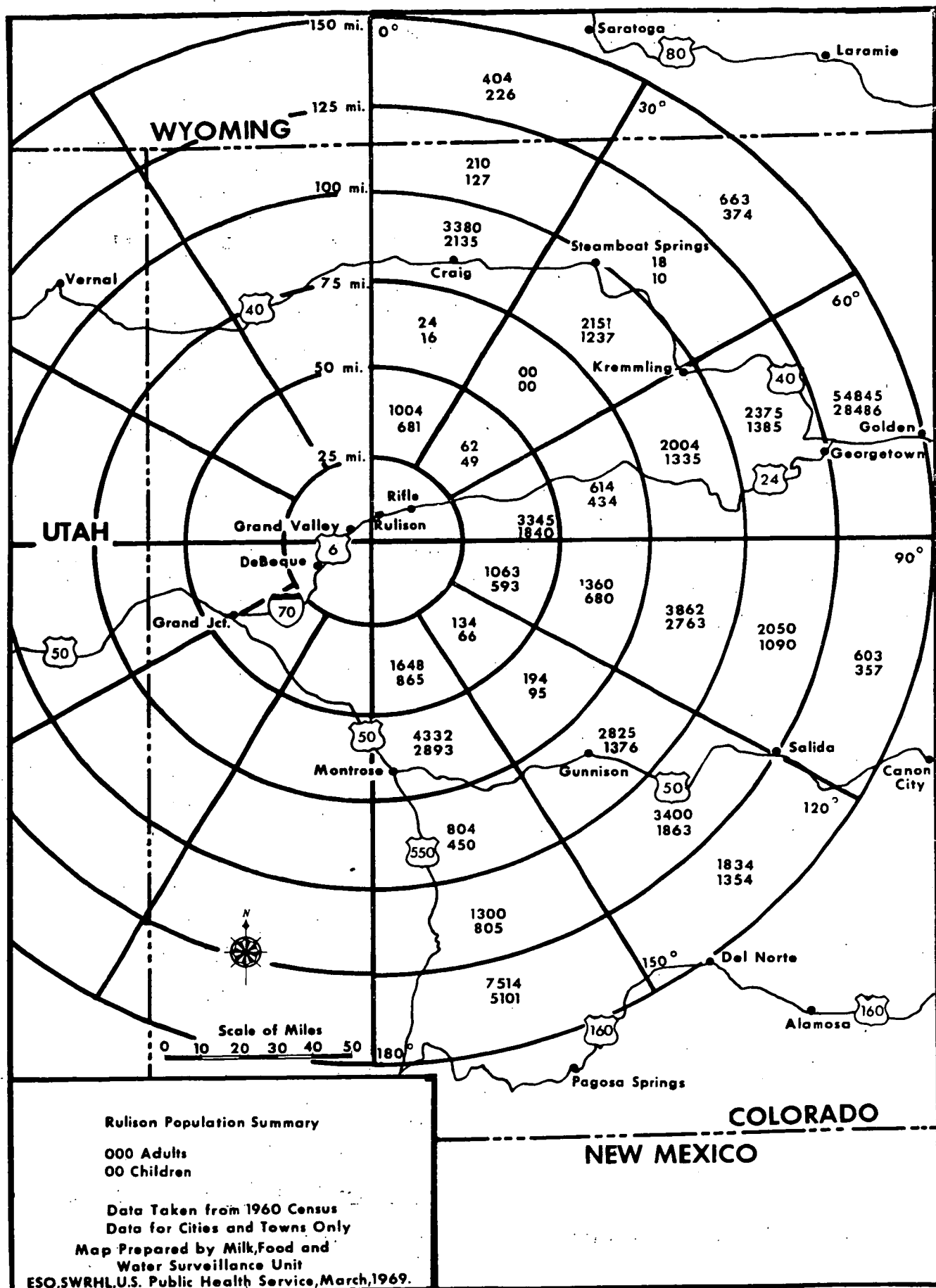
RULISON POPULATION SUMMARY

(Figure 7 - Page 19)

Population data on this small-scale map are taken from the 1960 census; figures are for cities and towns lying within the sectors.

The top figure indicates number of adults; the bottom figure indicates number of children. For example, the sector containing the town of Montrose contains 4332 adults and 2893 children.





3.6 Bioenvironmental (cont'd)

operation will be evaluated by the AEC Test Manager's staff prior to the detonation. The possibility of deleterious effects on wildlife as a result of ground motion have also been investigated. It has been concluded that no significant ecological hazard will exist.

3.7 Snow Slides

Current information indicates the possibility of snow slide hazard is remote. Conditions will be reevaluated at shot time and appropriate precautions taken if necessary.

3.8 Close-In Effects

Any partial blockage of Battlement Creek as a result of ground motion induced earth slides is predicted to be inconsequential. This hazard will be monitored at the time of the detonation and appropriate action taken, if necessary. Spalling or surface fracturing has been evaluated. It is predicted that downward percolation of stream water will not occur nor will more than a temporary, minor disturbance of the stream flow be observed. Measurement of the flow before and after the event will be made by the USGS at a gaging station near surface ground zero.

3.9 Aftershocks

Aftershocks in the form of microtremors have been observed in connection with large underground nuclear events for the past several years. However, these aftershocks have been found to be at least two seismic magnitude units less than the nuclear

3.9 Aftershocks (cont'd)

explosion. Experience with the Gasbuggy Event in New Mexico, the Shoal Event in an earthquake active region of Nevada, and numerous events at the NTS conducted at the relatively low Rulison yield level indicates that aftershock phenomena are not readily measurable.

A literature search for Colorado earthquakes of magnitude greater than 3 was performed by the Environmental Science Services Administration, U. S. Coast and Geodetic Survey (ESSA/C&GS). Of the 300 earthquakes identified, none had epicenters within 50 miles of the Rulison Site. This lack of seismic activity further reduces the probability of detectable aftershocks from Rulison.

3.10 Reservoir Structures

A study of the generation of water waves (seiches) in lakes or reservoirs by ground motion and the effects of ground motion on dams has been made. The preliminary evaluation revealed a possible hazard to the Harvey Gap Dam (Appendix A) and that insufficient information was available on the Battlement Mesa Reservoirs. Subsequent detailed analysis of Harvey Gap Dam and acquisition of additional information on the Battlement Reservoir dams concluded that complete failure is remote. However, the possibility of cracking or slumping of the embankments cannot be

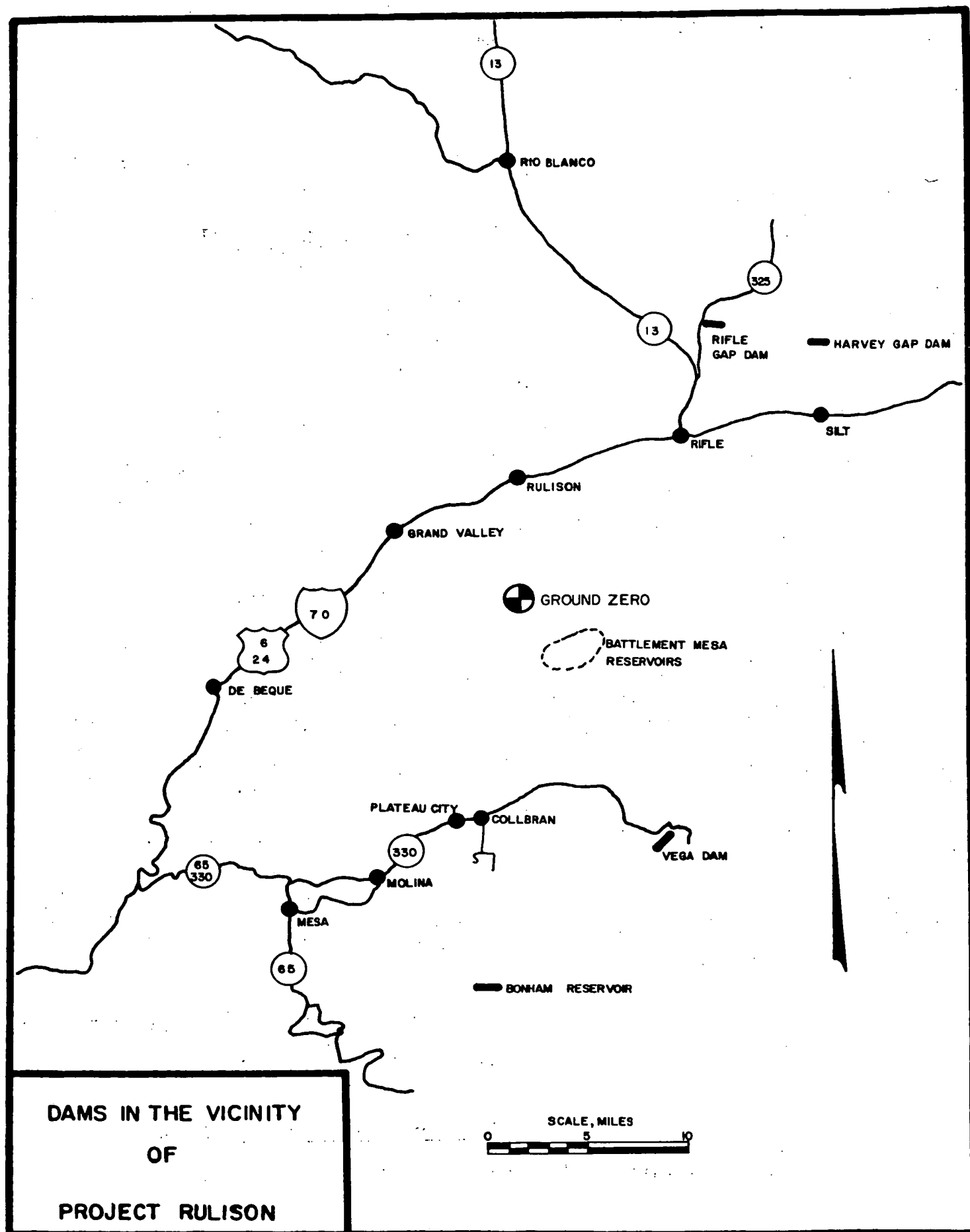
3.10 Reservoir Structures (cont'd)

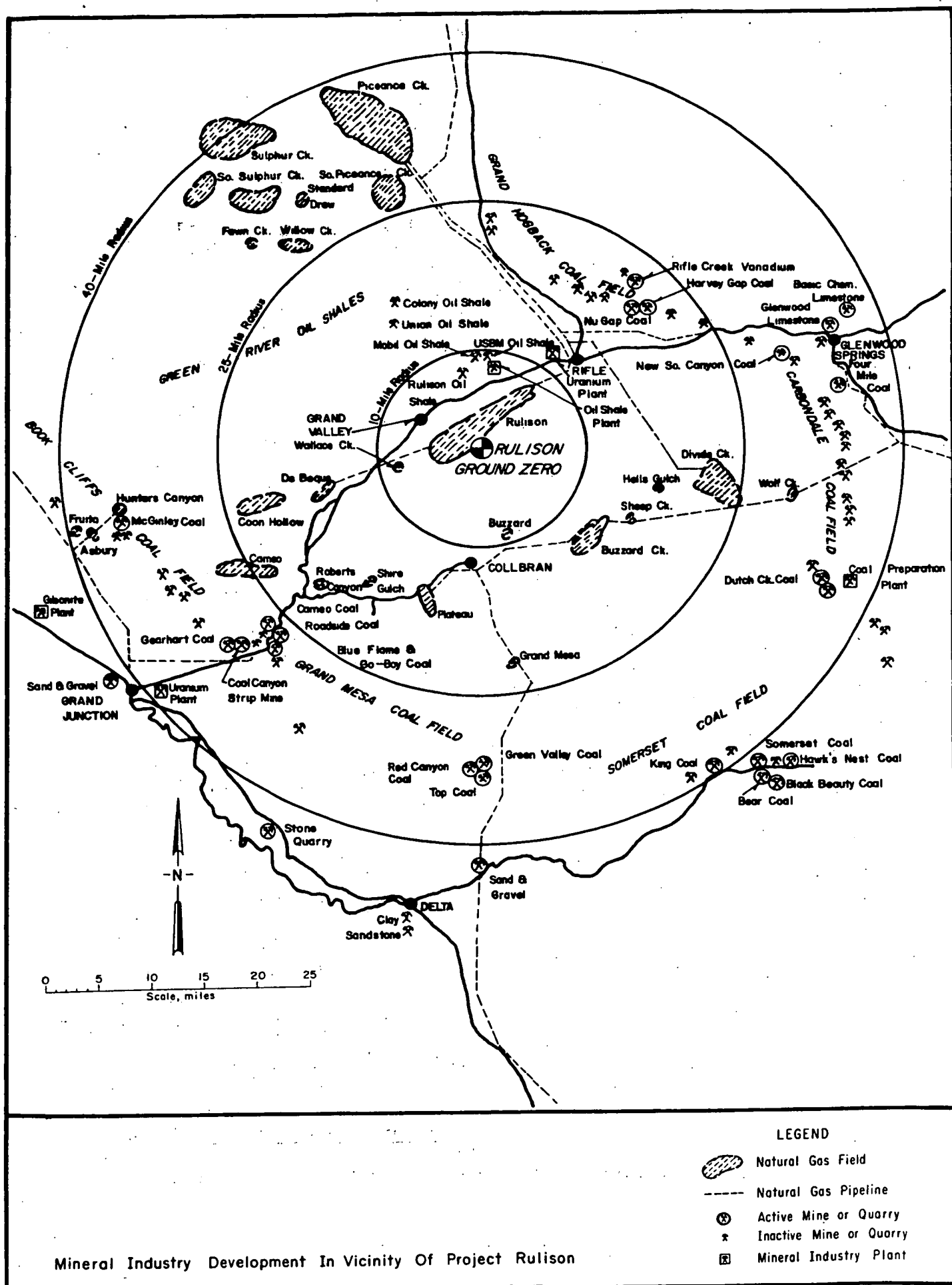
dismissed. Therefore, the NVOO Safety Panel of Consultants recommended that one of several alternative precautions be adopted (Appendix B). Depending on reservoir level, as indicated in Section 5.0, plans will be made to have residents in the area downstream of Harvey Gap Dam that could be affected by an uncontrolled discharge of the reservoir prepared to evacuate if post detonation conditions warrant.

It has been recognized that some slumping of banks of the Collbran Project irrigation distribution system and of the Union Carbide Plant Tailings Ponds near Rifle, Colorado could occur. Potential damage from this slumping particularly would be minor and preparation will be made to effect prompt repair. Seismic measurement (discussed in Section 4.1) of the response of Vega, Rifle Gap and Harvey Gap Dams will be taken in cooperation with the C&GS (Harvey Gap), the U. S. Corps of Engineers (Rifle Gap), and the U. S. Bureau of Reclamation (Vega). (Figure 8).

3.11 Mines and Gas Wells

The area to a distance of more than 40 miles from the Rulison Site was surveyed for any active or inactive mineral industry developments that might be affected by the detonation. (Figure 9). Within the 10 mile radius from ground zero are the USBM and Mobil Oil Shale Mines which may experience some minor rock fall damage. Out to 25 miles are the Union and Colony Oil Shale Mines, the Nu Gap





3.11 Mines and Gas Wells (cont'd)

and Harvey Gap coal mines and the Rifle Creek Vanadium Mine. The Mobil, USBM, Union and Colony Oil Shale Mines are research facilities that are not currently being operated. No special precautionary measures are necessary at the Mobil, USBM and Union Mines. The Colony Mine processing facilities are normally subjected to rock falls from adjacent cliffs. Evacuation of personnel that may be in the vicinity is recommended. For operating mines out to the distance of the Dutch Creek Mine personnel will be evacuated to avoid falling rock and noxious gases that might be released by the Rulison ground motions.

The distance to the nearest gas well is 2.8 miles. The nearest production well for the Gasbuggy Event experienced motions over 10 times that anticipated at this well from the Rulison detonation with no adverse effects. No special precautions are deemed necessary.

4.0 EFFECTS PROGRAMS

4.1 Seismic Instrumentation Program

For the Rulison Event, the C&GS will field 30 seismic instruments. (Table II). These instruments will measure motions at populated localities and provide data for extrapolation of motions to larger yields that could safely be used to improve gas production on a commercial basis. In addition, the Bureau of Reclamation and the

TABLE II

ESSA/C&GS SEISMIC INSTRUMENTATION PLAN

<u>Station</u>	<u>Distance (miles) & Bearing From SF</u>	<u>Station</u>	<u>Distance (miles) & Bearing From SF</u>
Control Point	3.0 N 34° 16' W	Union Carbide Corp.	11.3 N 37° 44' E
Lemon Ranch	4.3 N 5° 47' E	Collbran	11.3 S 9° 06' W
Eames Orchard	4.4 N 22° 45' W	Rifle	12.6 N 43° 14' E
Rulison	5.8 N 2° 54' E	Tosco Mine	18.5 N 32° 17' W
Grand Valley	7.1 N 58° 13' W	Silt	18.5 N 56° 11' E
Ranch	7.5 S 6° 05' W	Mesa	19.3 S 33° 11' W
Anvil Points	8.6 N 6° 55' E	Harvey Gap	20.8 N 46° 42' E
Mobil Mine (Portal)	9.5 N 3° 49' W	De Beque	15.3 S 72° 15' W
New Castle	25.0 N 61° 34' E	Canyon	21.1 S 57° 01' W
Cameo	26.6 S 49° 31' W	Delta	46.4 S 08° 04' W
Glenwood Springs	34.7 N 72° 29' E	Aspen	62.9 S 76° 54' E
Cedaredge	34.8 S 01° 34' E	Montrose	63.6 S 03° 34' E
Grand Junction	40.8 S 55° 38' W	Rangely	65.2 N 43° 48' W
Paonia	41.0 S 26° 59' E	Denver	157.0 N 81° 53' E
Meeker	44.1 N 01° 44' E	Salt Lake City	228.0 N 65° 59' W

4.1 Seismic Instrumentation Program (cont'd)

Corps of Engineers will cooperate in obtaining measurements of the response of dams to the induced ground motion. The dams will be instrumented on the crest, downstream face and on material similar to the dam foundation downstream from the dam. The U. S. Bureau of Mines (USBM) will install some 42 instruments in the USBM Oil Shale Demonstration Mine to measure roof vibrations, roof deflections and pillar strain that may be created by the Rulison ground motion. These measurements will enable the USBM to determine the response of the mine and evaluate whether this response is damaging.

4.2 Structural Response Program

"Condition surveys" of sensitive structures from close-in areas to distant areas such as Grand Junction, Montrose and Aspen will be made by JAB. These surveys are necessary to document their condition before and after the Rulison Event and to determine if damage is caused by ground motion from the detonation. JAB has presented a program for bracing structures (such as chimneys) to minimize damage. Passive displacement indicators will be installed on several of the structures chosen for detailed study. These passive indicators will be monitored periodically pre-shot, immediately prior to the detonation, and subsequent to the detonation to determine if any movement on existing cracks is due to the detonation itself or to natural phenomena.

4.3 Hydrologic Safety Program

The U. S. Geological Survey Water Resources Division has inventoried and sampled all water wells and significant springs within 10km of the detonation point. Measurements will be taken of the flow in Battlement Creek to determine the effect of the detonation on the ground and surface water supplies and flow. Thirty of the samples will be chemically and radiochemically analyzed pre- and post-detonation to determine if any change has resulted as a consequence of the detonation.

Particular attention will be paid to water levels, flow rates and structural conditions of existing wells and springs to be certain any post-event claims of damage can be adequately investigated.

4.4 Mines and Gas Wells

Mine condition surveys conducted by the USBM will include the Rifle Creek, Nu Gap, Cameo and Mobil, USBM, Union and Colony Oil Shale Mines. In addition to the surveys, instrumentation (indicated in Section 4.1) will be emplaced in the USBM oil shale mine to measure the response of the mine to the induced ground motion.

5.0 EFFECTS PREDICTION SUMMARY

The AEC DONO will define in the Operational Safety Plan any precautionary measures that will be instituted to minimize the possi-

5.0 EFFECTS PREDICTION SUMMARY (CONT'D)

bility of injury to persons or damage to property, both on and off the Rulison Site. The following is a summary of the hazards predictions (based on the maximum credible yield) that will be considered.

Peak horizontal ground motion predictions to a radius of 4.6 miles are in excess of .3g. A hazard could exist to all nonparticipating personnel in that area. To a distance of 4.6 miles fragile hanging objects should be removed by residents to a safe location and gas and electricity disconnected. In the town of Grand Valley, at the Anvil Point Research Station, and at various small ranches out to a radius of 8.7 miles, personnel will be instructed to be outside and away from structures to at least a distance of two building heights. At the Union Carbide Plant west of Rifle, personnel will be instructed to remain clear of concrete block structures and tanks during the event. If the event is detonated on school days or when schools may be occupied in the towns of Rifle and Collbran, students will be outside, away from the buildings during the event. At residences in the nearby area, primarily those closer than 15 miles, the residents will be notified that a possibility exists of precariously balanced objects and bric-a-brac falling if not removed or secured.

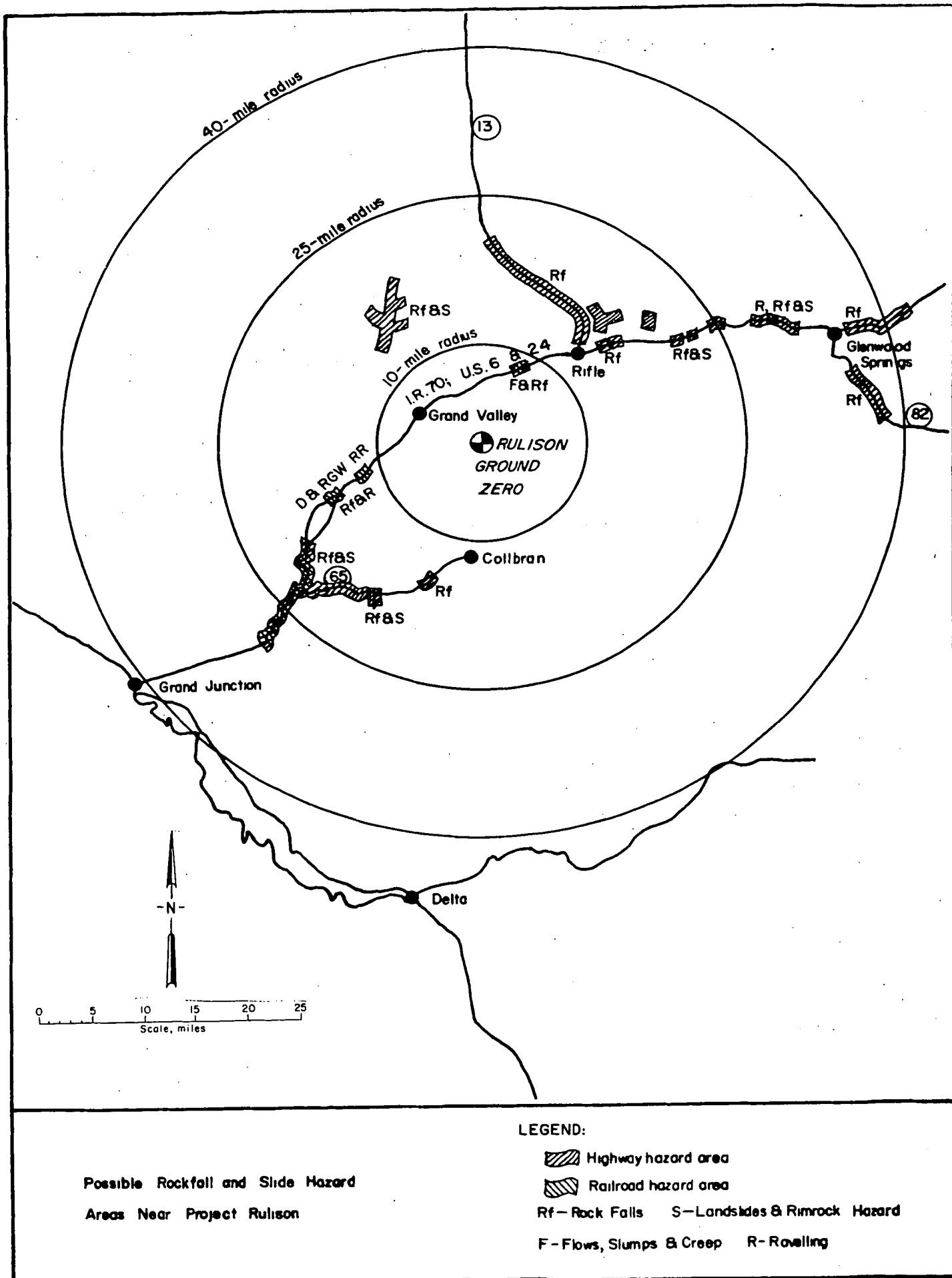
Personnel at the Cameo electrical generating plant will be instructed that they should refrain from being in high places or precarious positions at the time of the event.

5.0 EFFECTS PREDICTION SUMMARY (CONT'D)

Possible rock falls and landslides could occur on Interstate Highway 70 and the Denver and Rio Grande Railroad in De Beque Canyon from a point just east of Palisades to the vicinity of Akin Siding. Portions of the highway from Rifle through Glenwood Springs also could be subject to rock fall hazards.

Rock falls could also occur on State Highway 75 at its junction with Interstate Highway 70 to the intersection of State Highway 330. An additional short stretch of Highway 330 in the vicinity of Molina may also experience rock falls. Portions of Highway 789 between Rifle and Rio Blanco paralleling the base of high cliffs of the Grand Hogback and canyon portions of the roads to Rifle Gap and Harvey Gap Dams and through Parachute Creek to the Colony Mine have precariously balanced rocks and rock falls occur naturally at these locations. These rock fall and landslide hazard areas are identified on Figure 10. The DONO will regulate train and vehicle traffic at the time of detonation to prevent hazard to people or vehicles.

Within 50 miles, people will be notified to refrain from being in a precarious position at shot time. The motion is not expected to be severe. However, if a person is in a precarious position at shot time, he could become startled and possibly lose his footing. Precarious positions might include ladders or scaffolding and standing on roofs or high walls.



5.0 EFFECTS PREDICTION SUMMARY (CONT'D)

The motion that may be experienced at the closer locations would be of relatively high frequency and may be somewhat analogous to standing near a railroad track when a train passes. Farther from the detonation (probably at distances greater than 15 miles) the motion will impart more of a swaying sensation.

The following mines will be included in the pre- and post-shot safety inspection program. At these mines and the remaining operating mines out to the distance of the Dutch Creek Mine it is suggested that mine owners evacuate their facility. All operating mines within a radius of 50 miles of the detonation should be notified of the date and time of detonation.

<u>Mine</u>	<u>Operator</u>	<u>Miles to GZ</u>
Rifle Ck (vanadium)	Union Carbide	22
Nu Gap (coal)	Henry and Louis Bendetti	20
USBM (oil shale)	Dept. of Interior	10
Mobil (oil shale)	Mobil Oil Co.	10
Union (oil shale)	Union Oil Co.	15
Colony (oil shale)	Cleveland-Cliffs Iron Co.	17
Cameo (coal)	Juanita Coal & Coke Co.	26

As indicated in Section 3.11, it is a remote possibility that the Harvey Gap Dam could be damaged as a result of the minor additional

5.0 EFFECTS PREDICTION SUMMARY (CONT'D)

loading of the dam by the seismic motion. The recommendation to reschedule the detonation for early fall (September) will result in the water elevation in the reservoir being at least 15 feet below the crest of the dam. Plans will be made to arrange for people in the downstream area that could be affected by an uncontrolled discharge of the reservoir to be evacuated after the detonation if the reservoir is 15 to 20 feet below the dam crest. No hazard to the downstream area exists if the reservoir is 20 feet below the crest. The dam, however, will be monitored so any damage can be promptly repaired. The locations downstream from the Battlement Reservoirs that could be affected by an uncontrolled discharge will be evacuated for other reasons. No special precautions will be necessary.

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APPENDIX A

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Mr. Robert E. Miller, Manager
Nevada Operations Office
U. S. Atomic Energy Commission
P. O. Box 14100
Las Vegas, Nevada 89114

April 11, 1969

Dear Mr. Miller:

The members of the NVOO Safety Panel of Consultants met on April 11, 1969 at Las Vegas. The Panel reviewed the ground motion and structural response predictions for Event Rulison and considered in some detail the safety aspects of the program for this event. This report contains the comments and recommendations of the Panel on this topic.

The Panel reviewed data presented to it on predicted ground motions from the detonation and the nature and possible extent of damage to structures at various distances, the possible damage to mines, the possibility of local rock slides, and the possibilities of failure of several dams in the general vicinity of the shot. The Panel also reviewed the precautionary measures proposed to accommodate the motions and damage potential. In general, the Panel feels that the predictions of motion are reasonable and conservative and that the estimates of damage to structures are in accord with previous experience and general scientific concepts.

The precautionary measures proposed appear adequate and we feel that damage or failure of structures close to ground zero have been evaluated and measures suggested that will avoid danger to personnel and domestic animals. The proposed control of traffic in areas vulnerable to rock falls, rock slides and slope failure will render minimal the dangers from such effects. Some damage may be expected in mines not currently in operation that are close to ground zero, but no special precautionary measures appear necessary there. For operating mines somewhat further away, the Panel recommends that personnel be evacuated to avoid exposure to falling rock and noxious gasses that might be released by such motions. It would be desirable to evacuate the mines out to a distance that includes the Dutch Creek Mine.

The Panel reviewed the data presented relative to ground water contamination and feels that the information presented by the USGS is in accord with practices and standards previously accepted by the Panel. In our opinion there is little probability that ground water contamination will be a problem. The Panel is in agreement with the proposed hydrologic safety and monitoring program described in the report "Effects Evaluation - Project Rulison", dated April 1969.

In general, therefore, in all respects save one, the Panel feels that the safety program for Rulison is acceptable and appropriate. However, we feel that we must make an exception to this statement in regard to safety of Harvey Gap Dam. Insufficient information has been made available regarding the properties of the materials of which the dam is constructed, the nature of the outlet works, and the present factors of safety of the dam with regard to failure even without ground motions related to a nuclear test. The Panel cannot accept without reservations a precautionary measure that would avoid damage by lowering the water level in the reservoir behind the dam before the event. It may not be possible to do this because of the volume of inflow that is presently occurring, and because of the limited size of the outlet channel. Moreover, the dam is believed to be composed of relatively impervious material and if this is the case would be subjected to large internal hydrostatic pressures following rapid draw-down. These pressures may reduce the safety of the dam to the extent that a relatively slight shock may result in its failure and consequent damage to downstream areas. There has been a failure of the original dam which was raised by construction of a new section. The new dam apparently has experienced approximately four feet of settlement since it was constructed. Moreover, there are evidences of piping near the spillway channel and perhaps at other points in the dam. Physical properties of the dam material have not been investigated nor have calculations been made of the stability of the dam under static or dynamic conditions. We strongly recommend that the determination of the properties and the necessary calculations be performed so that precautions can be taken to avoid failure of the dam. If this is not done, and assurance of the safety of the dam is not available it will be necessary to provide protection to downstream areas. Naturally this involves the acceptance of failure as one of the effects of the event. The conditions affecting the dam might be less severe in the fall when the reservoir level is low and the dam itself is not completely saturated.

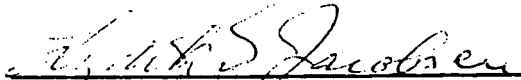
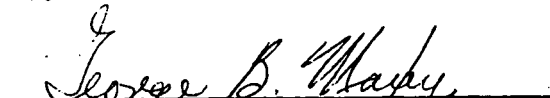
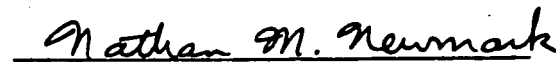
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The Panel recommended in a letter of 27 February 1969 that Rifle Gap Dam, Vega Dam, and Harvey Gap Dam, be instrumented to obtain information about their response ground motions. The Panel recommends that where this instrumentation is provided, the properties of the materials be obtained in order to permit interpretation of the data.

Respectfully submitted,



Dr. Don U. Deere


Dr. Lydik S. Jacobsen
Dr. George B. Maxey
Dr. Nathan M. Newmark
Mr. Thomas F. Thompson

Reviewed and Concurred In:


Mr. Stanley D. Wilson

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APPENDIX B

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Mr. Robert E. Miller, Manager
Nevada Operations Office
U. S. Atomic Energy Commission
Post Office Box 14100
Las Vegas, Nevada 89114

May 1, 1969

Dear Mr. Miller:

The members of the NVOO Safety Panel of Consultants met on May 1, 1969 and reviewed the most recent data pertinent to the Rulison Event. These data were developed and presented as a result of the request contained in the Panel's letter of April 11, 1969.

Discussions were held with representatives of the following:

- U. S. Bureau of Reclamation
- U. S. Geological Survey
- Waterways Experiment Station, Corps of Engineers
- State of Colorado
- John A. Blume & Associates
- Environmental Research Corporation
- Members of the Staff of NVOO
- Isotopes, A Teledyne Company
- Austral Oil Company
- CER Geonuclear Corporation

It was stated in the letter report of April 11, 1969, prepared by the Panel that ". . . there is little possibility that ground water contamination will be a problem." The present report is concerned with ground motion effects with special consideration of Harvey Gap Dam; however, possible hazards at Battlement Mesa, Union Carbide's Tailing Pond; and canals in the Collbran Project were also evaluated.

Harvey Gap Dam

The Panel reviewed data presented to it regarding the stability and safety of Harvey Gap Dam. The Panel concurs with the findings of the contractors and their consultants that careful observations of the dam during and subsequent to the shot be made to assist in evaluation of future shots. These observations should include alignment and settlement measurements of the crest, as well as recordings of transient velocities during the period of ground shock.

The Panel feels that failure of the embankment is extremely remote, but cannot dismiss the possibility of either cracking or slumping. Therefore, one of the following alternates should be adopted to assure the safety of people living below the dam:

Alternate No. 1: Postpone the shot until such time as the reservoir is lowered by irrigation withdrawals to a level at least 15 feet below crest elevation. Provide for timely post-shot evacuation of people downstream if circumstances warrant.

Alternate No. 2: Lower the elevation immediately by discharging and wasting water such that the reservoir level is lowered to 15 feet below the crest. Provide for timely post-shot evacuation of people downstream if circumstances warrant.

Alternate No. 3: Lower the water elevation to 10 feet below the crest and provide stockpiles of sand and gravel with loading equipment at the dam so that cracks can be quickly repaired. Evacuate people during the event from that area downstream that could be flooded by uncontrollable discharge of the reservoir over a several hour period.

Battlement Mesa Dams

The Panel considered the possibility of failure of several or all of the small dams on Battlement Mesa. Even in the unlikely event that all reservoirs failed more or less simultaneously, with normal AEC precautionary measures, there would be no hazard to life and potential property damage would be within acceptable limits.

R. E. Miller

- 3 -

5/1/69

Collbran Project

With regard to slumping of canal banks causing temporary damage to canals and other structures of the Collbran project, the probable damage is considered to be acceptable. The probability of damage would be lessened were the shot to occur in late summer or fall.

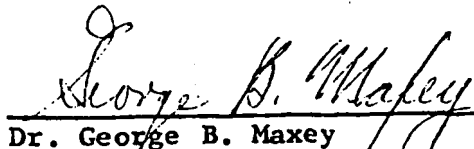
Tailing Ponds

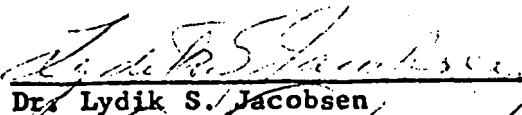
With regard to the Union Carbide Tailing Ponds, no hazard to life exists and potential property damage is within acceptable limits.

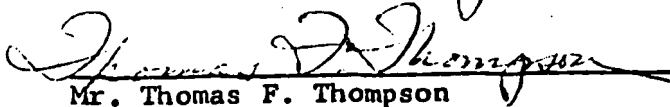
The representatives of the Waterways Experiment Station, Corps of Engineers, concurred with the recommendations of this report relative to Harvey Gap Dam.

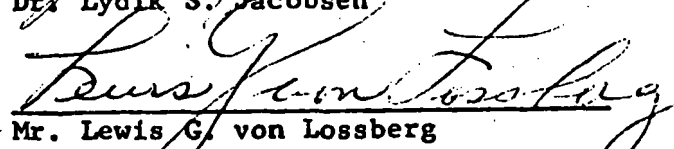
This report telephoned to Dr. Newmark, who expressed his concurrence.

Respectfully submitted,


Dr. George B. Maxey


Dr. Lydik S. Jacobsen


Mr. Thomas F. Thompson


Mr. Lewis G. von Lossberg


Mr. Stanley D. Wilson